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Fluid Cooling Device

The invention relates to a fluid cooling device as a structural unit having a drive motor which drives a fan wheel and a fluid pump which delivers a first type of fluid to a fluid working circuit which in operation basically heats the fluid, and leads to a heat exchanger from which the fluid returns cooled to the fluid working circuit.

EP 0 968 371 B1 discloses a fluid cooling device as a structural unit with a drive motor which drives a fan wheel and a fluid pump which takes fluid (hydraulic medium) from an oil tank and delivers it to a hydraulic working circuit which heats the fluid, and leads to a heat exchanger from which the fluid returns cooled to the oil tank. In the known solution the oil tank is made trough-shaped, and with its upwardly drawn edges in the manner of a half shell at least partially encloses the motor and the fluid pump. Accordingly, with the known solution the oil tank has a relatively large volume and is still a component of the fluid cooling device in a space-saving compact design and moreover ensures good accessibility of the motor and fluid pump unit for mounting and maintenance purposes as a result of the installation space left open by the trough edges. In addition to a compact design for the fluid cooling device, the result is moreover that the mass components of the cooling device are uniformly distributed, so that in operation a safe upright position is achieved even with the corresponding inherent movements and vibrations.

A control system and process for controlling the speed of a plurality of fans for cooling a plurality of flow agents in a machine are disclosed in DE 100 62 534 A1, the speed of each fan being controlled according to the individual heat dissipation requirements of special heat transfer cores which are attended by this special fan, this control system having a plurality of sensors which are positioned to sense the temperature of each of the plurality of flow agents, and each sensor can be operated to output a signal which indicates the temperature of this special flow agent, and an electronic control device which is coupled to a plurality of sensors in order to receive signals from them which pick up the temperature of each of the plurality of flow agents. Based on these temperature signals, in the known device the electronic control module can determine a corresponding temperature error for each of these flow agents, and based on these temperature error signals and on a certain logic which has been programmed into the electronic control module, the control device outputs a signal to each of the plurality of fans in order to individually control their speed, each output signal indicating a desired fan speed for this special fan.

With the existing solutions however only one cooling task can ever be performed, i.e., efficient cooling of the heated fluid of a first type, for example in the form of a hydraulic medium. For other cooling and temperature-control tasks, for example cooling a fluid of a second hydraulic working circuit (gear oil), the known devices must be provided again so that an independent cooling device with a drive motor, pump, and cooler consequently is required for each hydraulic circuit and each cooling task.

On the basis of this prior art, the object of the invention is to further improve the known solutions such that several temperature-control tasks can be performed with only one fluid cooling device. This object is achieved by a fluid cooling device with the features of claim 1 in its entirety.

In that, as specified in the characterizing part of claim 1, by means of a second fluid pump of the device a second type of fluid can be taken from a storage tank and can be delivered to a second

fluid working circuit from which the second type of fluid returns in a guided manner to the storage tank by way of the first and the second heat exchanger, various temperature-control tasks for separate fluid working circuits can be performed with only one fluid cooling device. Furthermore, with the solution as claimed in the invention it is possible, especially by way of the first heat exchanger, to effect heat exchange between the two types of fluid; this on the one hand leads to a more uniform heat state for the two fluid media, and on the other can also afford the advantage of heating relatively cold working fluid of a circuit when parts of machinery and systems are started by way of the then possible warmer fluid medium of the other circuit in order in this way to clearly increase the operating reliability and operating precision.

The fluid cooling device as claimed in the invention is especially suited for cooling of electric drives such as linear motors, as are used for example in machining centers and machine tools, where cooling of the electrical components takes place by means of a water-glycol mixture. Furthermore it can be used for other linear motors, motor spindles, servo motors and comparable devices. The cooling medium in the form of a water-glycol mixture as the second type of fluid is relayed to a plate heat exchanger of the fluid cooling device and there in countercurrent cools the hydraulic medium of a hydraulic fluid working circuit to which likewise the machining center or the machine tool with its drivable components is connected. Due to the heating caused thereby the water-glycol mixture, before it travels back into the storage tank of the fluid cooling device, is cooled by way of a second heat exchanger in the form of a finned radiator. During start-up, that is, when the hydraulic working circuit with the connected machining center or machine tool is started up, the hydraulic working medium is generally cold and can then by heated up by way of the water-glycol medium which has been heated to a greater degree. A reliable and precise start-up of operation is achieved. Furthermore, in this way the ratio of the temperatures between the electric components and the hydraulic oil of the hydraulic oil circuit can be optimized; this likewise contributes distinctly to improving the machining precision.

Other advantageous embodiments are the subject matter of the other dependent claims.

The fluid cooling device as claimed in the invention is detailed schematically below, not to scale, in the drawing of one embodiment.

The single figure shows in a rear view the fluid cooling device as a structural unit in its installation position.

The fluid cooling device shown in its entirety in the figure has an electric drive motor 10 which drives a fan wheel 12 with individual fan blades. Furthermore, the drive motor 10 drives a fluid pump 14. The fan wheel 12 is held in a fan wheel housing 16 which is built preferably from sheet metal parts. For the sake of safety the fan wheel 12 is covered with a protective grate 18 in the rear area. In the rear area a flange part 20 which is provided with openings and on which the unit consisting of the drive motor 10, fan wheel 12 and fluid pump 14 is supported extends over the opening of the fan wheel housing 16. Above the fan wheel housing 16 there is a heat exchanger 22 in the form of a plate heat exchanger. Furthermore, toward the front the fan wheel housing 16 is covered by a second heat exchanger 24 in the form of a finned radiator which extend over the entire free opening cross section of the fan wheel opening 26. The fan wheel 12 is designed as an axial intake fan which, viewed in the direction of looking at the figure, draws air from right to left through the fins of the second heat exchanger 24 and moves it rearward into the rear area in the direction of the drive motor 10.

With a suitable adaptation it is however also possible to reverse this air flow and to design the fluid cooling device as an axial pressure fan. In order to keep the fins of the finned radiator (second heat exchanger) 24 free of dirt, on its free front side it is overlapped by a plate-shaped air

filter 28. The fan wheel housing 16 is designed as a hollow box and stands vertically on a storage tank 30 which forms an increased tank chamber volume to increase its fluid volume in the rear area in the vertical direction. Adjacent to the first drive motor 10 in the back area of the storage tank 30 a submersible pump 32 is seated on the latter, the pump parts for removing fluid from the storage tank 30 projecting into the latter (not shown). Accordingly the drive motor 34 of the submersible pump 32 is visible in the figure. This submersible pump 32 has a pump opening 36 for removing fluid from the storage tank 30.

This pump opening 36 supplies a fluid working circuit which is not shown and which is used preferably for cooling the electric linear drive of a machining center or a machine tool. Especially a water-glycol mixture (second type of fluid) is used as the fluid, and after passing through the electrical consumer for its cooling the water-glycol mixture is delivered by way of the submersible pump 32 into the plate heat exchanger 22, specifically by way of corresponding tubing which is not detailed and which discharges into the lower port 38 of the plate heat exchanger 22. From there the second type of fluid (water-glycol mixture) flows through the plate heat exchanger 22 and leaves it by way of the lower delivery port 40.

This delivery port 40 is in turn connected to carry fluid to the second heat exchanger 24 by means of a transverse pipe 42 and the water-glycol mixture which has been heated in the plate heat exchanger 22 is cooled during operation of the fan wheel 12 by means of cooling air in the second heat exchanger 24 in the form of a finned radiator by the water-glycol mixture traveling in this way through the second heat exchanger 24. After passing through this cooling step, the water-glycol mixture travels by way of the connecting pipe 44 back into the storage tank 30 which in this respect establishes the connection between the top of the storage tank 30 and the top of the second heat exchanger 24 to carry fluid. After return to the storage tank 30, this water-glycol mixture is available cooled for a new circulation process by means of the submersible pump 32.

The already mentioned fluid pump 14 is used to deliver a first type of fluid in the form of a hydraulic medium such as hydraulic oil. With this hydraulic oil the hydraulic assemblies of a machining center or a machine tool can appropriately be triggered and operated. The storage tank for the hydraulic oil is located outside of the fluid cooling device shown in the figure so that from there the fluid pump 14 intakes the hydraulic oil by way of its intake opening 46 and relays it to the pump line 48. This fluid-carrying pump line 48 is in turn connected to the plate heat exchanger 22 above the delivery port 40 by way of the input opening 50. The hydraulic oil travels by way of the pertinent input opening 50 into the plate heat exchanger 22 and flows through it in countercurrent to the water-glycol mixture from left to right. Then the hydraulic oil which has been cooled or temperature-treated in this way travels by way of the outlet 52 which is located above the lower port 38 back into the hydraulic working circuit which is not detailed and to which the hydraulic assembly and the hydraulic tank of the entire system are connected.

With the fluid cooling device as claimed in the invention, it is therefore possible to cool heated hydraulic oil of a system by way of the plate heat exchanger 22, this cooling or temperature control taking place in countercurrent by way of the water-glycol mixture which, stored in the storage tank, is delivered by the submersible pump 32 for circulation. The water-glycol mixture heated in the plate heat exchanger 22 is then cooled by way of the finned radiator 24 as it continues to circulate. If at the start of operation of the hydraulic system the hydraulic medium is cold, it is possible to heat the cold hydraulic oil by way of the water-glycol mixture which may be warmer and in this way to facilitate the start-up of operation. Furthermore, with respect to the interface in the form of the first heat exchanger 22 the temperature behavior in the two circuits is made uniform; this in turn affects the machining precision for the entire system.

The illustrated fluid cooling device can also be used for other applications in which temperature-control tasks for different fluid circuits arise. Furthermore, it is possible to insert or mount separable tank chambers in the storage tank 30 so that other fluid media can be stored by way

of the storage tank of the fluid cooling device as a structural unit. It is also possible, in addition to the illustrated fluid pump 14 and the submersible pump 32, to mount other pumps together with other heat exchangers 22, 24 (not shown) in order to thus trigger more than two fluid media with respect to temperature.